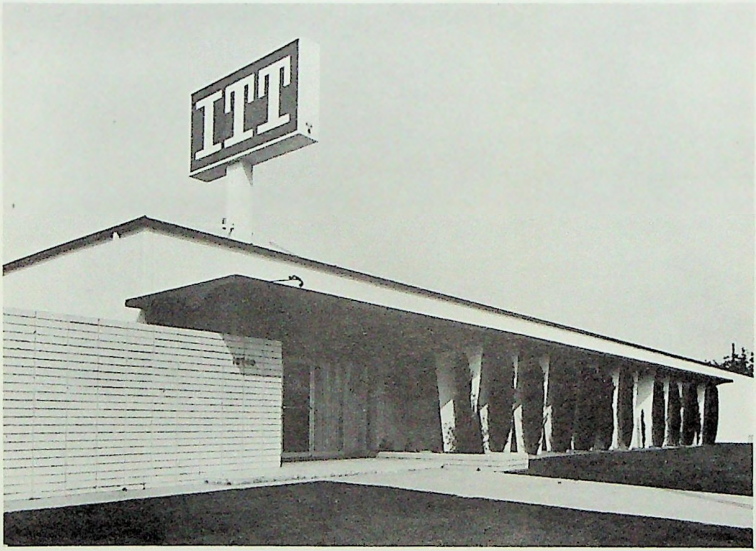
ADVANCED ELECTRO-OPTICAL LABORATORIES



A FACILITY FOR
ELECTRO-OPTICAL TUBE AND DEVICE
RESEARCH AND DEVELOPMENT

ELECTRON TUBE DIVISION
12740 SAN FERNANDO ROAD, SAN FERNANDO, CALIFORNIA 91342 • TELEPHONE (213) 367-1801 • TWX 910-496-1688

- ORGANIZATION
- CAPABILITIES
- FACILITIES

ADVANCED ELECTRO-OPTICAL LABORATORIES

ITT ELECTRON TUBE DIVISION

12740 SAN FERNANDO ROAD, SAN FERNANDO, CALIFORNIA 91342

BACKGROUND AND CAPABILITIES

The Advanced Electro-Optical Laboratories of the ITT Electron Tube Division have been a leader in establishing the state-of-the-art in photoelectronic image tubes and electro-optical tube devices. The experience, the personnel, the organization, and the facilities are available for performing advanced research and development programs on electro-optical tubes and devices of many types and functions.

The experience has been gained from the successful completion of a larger number of photoelectronic image tube and electro-optical device contracts over a long period of years. The professional staff has the advanced education and practical experience in all areas of knowledge vital to the advancement of electro-optical tube technology, while the technicians have the training and skills necessary to produce the tubes and devices which establish the state-of-the-art. The organization is self-contained for quick response to customer requirements, yet has the backing and stability of both a large national division and an international corporation. The facility, first occupied in mid-1969, was designed, built, and equipped specifically for the research and development of advanced electro-optical tubes and devices. The equipment available is the best of modern hardware for tube fabrication and research support. Although the total operation is oriented in general toward low light level tubes and devices, it is also qualified and capable of performing work involving conventional image tubes, camera tubes, and storage tubes.

An outstanding record of accomplishments has been compiled in the technical areas of photoelectronic tubes, electro-optical devices, tube components, and image tube technology. In the area of tubes, the Advanced Electro-Optical Laboratories have successfully performed contracts on storage tubes, proximity focused image tubes, electrostatic and electromagnetic focus image converters, Generation II intensifier camera tubes (the CINTICON™ and coupled intensifier tubes), and Generation II proximity, electrostatically, and magnetically focused channel intensifier tubes. Tubes have ranged in size from 18 mm to 80 mm. Some typical unclassified types are shown in Figure 1. Utilizing its own tubes, the Advanced Electro-Optical Laboratories have completed contracts for electro-optical

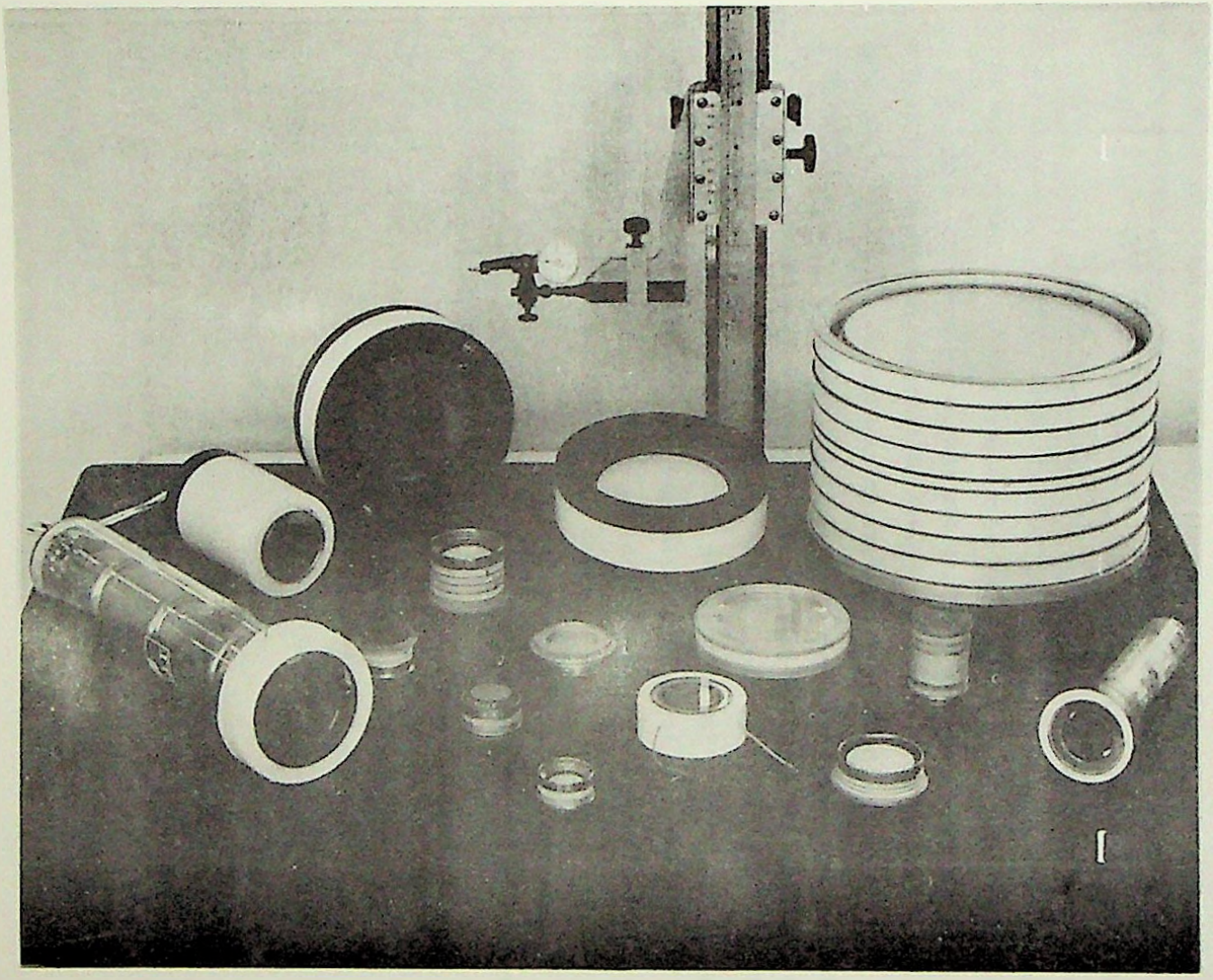


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Figure 1. Typical Unclassified Image Tubes

devices such as the prototype Night Vision Goggles, infrared satellite tracking telescopes, special purpose spectrometers, and other classified electro-optical systems. In the area of electro-optical tube components, the Advanced Electro-Optical Laboratories are equipped to fabricate micro-channel plates, the heart of all Generation II image intensifiers, by the etched core, multiple draw process, or by a new ITT-developed hollow draw process. Many important advances in image tube and component technology have been made by AEOL. Tube fabrication technology has been advanced by the development of metal-ceramic tube fabrication techniques for Generation II image tubes, in-vacuum, external photocathode processing and batch processing equipment which allows the final assembly of several tubes at once on a single vacuum processing station. Advanced methods of MCP processing such as improvements in preactivation treatment and activation techniques have been developed by AEOL in conjunction with its tube programs. Improvements in MCP fabrication technology continue to be made by applying more precise techniques to producing etched core MCP's and further development of the hollow drawn MCP. The multiple goals of both the MCP and tube programs are to remove all fixed pattern noise, reduce dynamic noise, increase gain and reduce production costs.

Indicative of the wide range of capabilities and interests of the Advanced Electro-Optical Laboratories is the partial listing of current or completed contracts shown in Table I.

Contract	Title	Year Awarded
AF33(616)–5626	Infrared Image Converter Studies	1958
DA–44–009–ENG–4699	Integrating Image Tube	1960
DA–44–009–ENG–4720	Microminiature Wafer Intensifier Study	1960
AF33(616)–8164	Electron Recording Media Study	1961
AF04(694)–108	Radiation Properties Study	1962
DA–44–009–ENG–5145	Rapid Scan Spectrometer	1962
DA–44–009–ENG–5115	Wafer Image Intensifier (CIT)	1962
DA–44–009–ENG–4974	Controlled Activation Techniques (MCP)	1962
ITT General Development	Optical Target Recognition Devices	1963
ITT General Development	Image Intensifier Vidicon	1964
DA–44–009–AMC–920(T)	Goggles (NVG Feasibility)	1965
DA–44–009–AMC–1112(T)	Etched Core Microchannel Plates	1965
N0009–67–C–0041	6 Inch Photoreconnaissance Tube	1966
DA–44–009–AMC–1813(E)	Storage Tube, Model 1	1966
DA–44–009–AMC–1595(T)	18 MM Channel Intensifier Tube	1966
AF33(615)–3219	Fiber Optic Output, Channel Intensifier Tube	1967
ITT General Development	Solid State Image Intensifier	1967
DA–44–009–AMC–1439(T)	SEC Image Intensifier Vidicon (CINTICON™)	1967
ITT General Development	Microchannel Plate Facility	1967
DAAK02–68–C–0255	25 MM Proximity Focused Channel Intensifier Tube	1968
Classified, IT3413	75 MM Channel Intensifier Tube	1968
DAAK02–69–C–0009	Night Vision Goggles (18 mm channel intensifier tube, trifocal input, fiber optics inverter output)	1968
DAAK02–68–C–0247	40 MM Magnetically Focused Channel Intensifier Tube	1968
N00123–70–C–0071	CINTICON™ Camera Tube	1969
DAAK02–68–C–0258 —Mod. P005	ITT Life Enhancement Program for Wafer Tubes	1970
DAAK02–70–C–0358	Advanced Manufacturing Techniques for Hollow–Drawn MCP's	1970

Table I. List of Typical Contracts

THE CORPORATE ENVIRONMENT

The Advanced Electro-Optical Laboratories of the ITT Electron Tube Division is an operating unit of ITT Aerospace, Tubes and Electro-Optical Operations (ATEO). as shown in the functional organization chart in Figure 2. ATEO is one of many ITT organizations in the U.S.A. which report to the ITT Defense-Space Group. It can be seen from the chart that ATEO. with headquarters in San Fernando, California, comprises two divisions: The Aerospace/Optical Division (A/OD) and the Electron Tube Division (ETD), which have facilities at Fort Wayne, Indiana, San Fernando, California, Easton. Pennsylvania. and Roanoke, Virginia. In both Fort Wayne and San Fernando. the physical proximity of the A/OD and ETD organizations permits a high degree of interchange in the use of facilities and personnel. Throughout all ATEO responsible organizations, in addition to the particular product orientations of each operating unit, there is a strong common interest in programs requiring project organization across units, such as was accomplished for the U. S. Army's Night Vision Goggles Program. This interest and capability permits the best utilization of facilities and personnel within ATEO toward the successful accomplishment of programs involving a variety of technical areas.

THE INTERNAL ORGANIZATION

The ITT Advanced Electro-Optical Laboratories are functionally organized along the lines of the chart shown in Figure 3. Mr. C. V. Stanley is the Vice President and General Manager. The organization is designed to support efficiently the Laboratories' various technological areas of interest. Personnel may be drawn from the various groups to satisfy the requirements of a particular program. The project manager may report to one of the group managers or directly to the laboratory director.

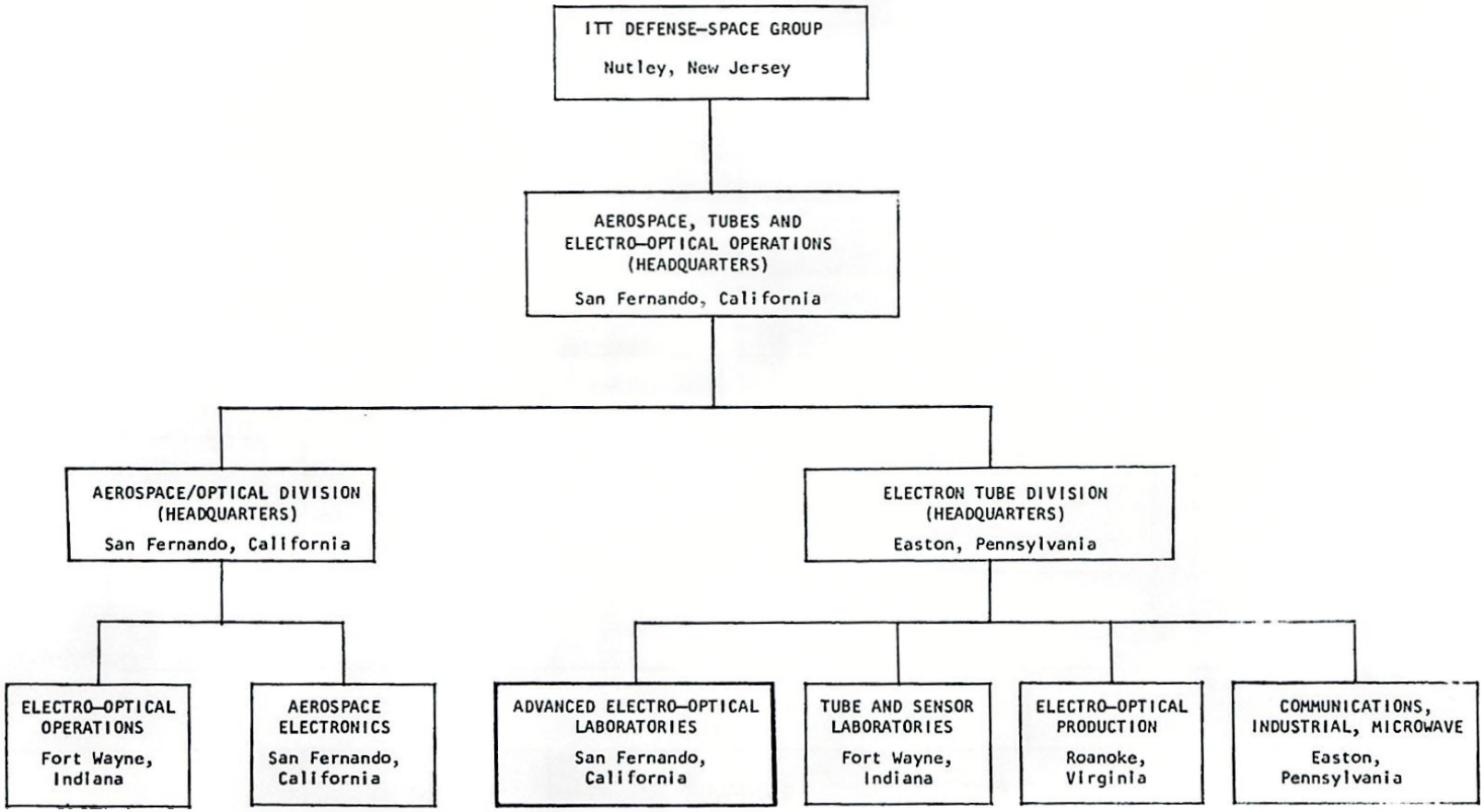

Figure 2. Corporate Relationships of ITT Advanced Electro–Optical Laboratories

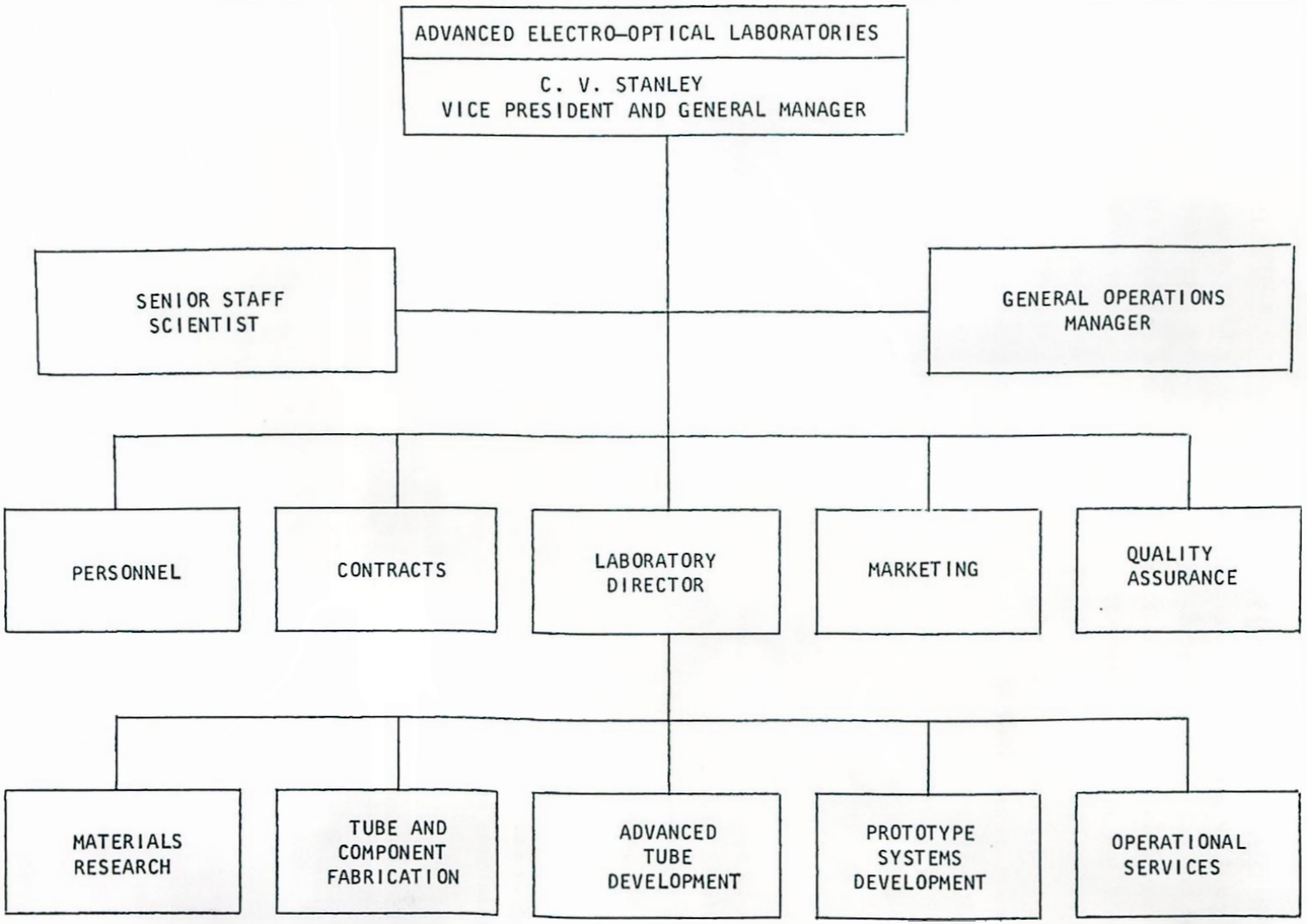

Figure 3. Organization of Advanced Electro-Optical Laboratories

ADVANCED ELECTRO-OPTICAL LABORATORIES' FACILITY DESCRIPTION

The Advanced Electro-Optical Laboratories facility of the ITT Electron Tube Division is located in the northern apex of the San Fernando Valley. It occupies a modern, air conditioned building with approximately 26,000 square feet of floor space. An exterior view of the building is shown on the cover of this brochure. The building was constructed and equipped specifically for the design, development, and pilot production of both direct viewing and electrical output, photoelectronic image tubes. Included is high capacity electrical service and piped supplies of all gases required for tube research and fabrication of not only low light level tubes, but also conventional image tubes, vidicons, and storage tubes.

Those portions of the facility devoted to the production of image tubes and components have been designed to ensure against airborne and personal contamination of sensitive tube components by the use of controlled environment clean rooms with filtered, positive pressure air conditioning, air locks, laminar flow assembly benches and clean room apparel. The various areas have been arranged in a functional relationship, and the handling of components is minimized by the use of pass through compartments for the transfer of components between areas during the fabrication sequence. The provision of a clean, standardized environment and the use of standardized fabrication procedures maximizes the ratio of successfully completed tubes to tube starts.

Figure 4 is a diagram of the Advanced Electro-Optical Laboratories showing the layout of space devoted to engineering, management, research and production of photoelectronic image tubes. The following paragraphs and figures provide a brief functional description of each area.

Chemical Cleaning

Prior to incorporation into tube subassemblies, incoming tube components receive a thorough systematic cleaning. In this area, shown in Figure 5, four fume hoods and stoneware sinks are available for the cleaning of components with acids, alkalis, and various solvents. Other equipment includes a super heated steam cleaner, a vapor degreaser, ultrasonic cleaners, water demineralizing still, drying ovens, and a centrifuge.

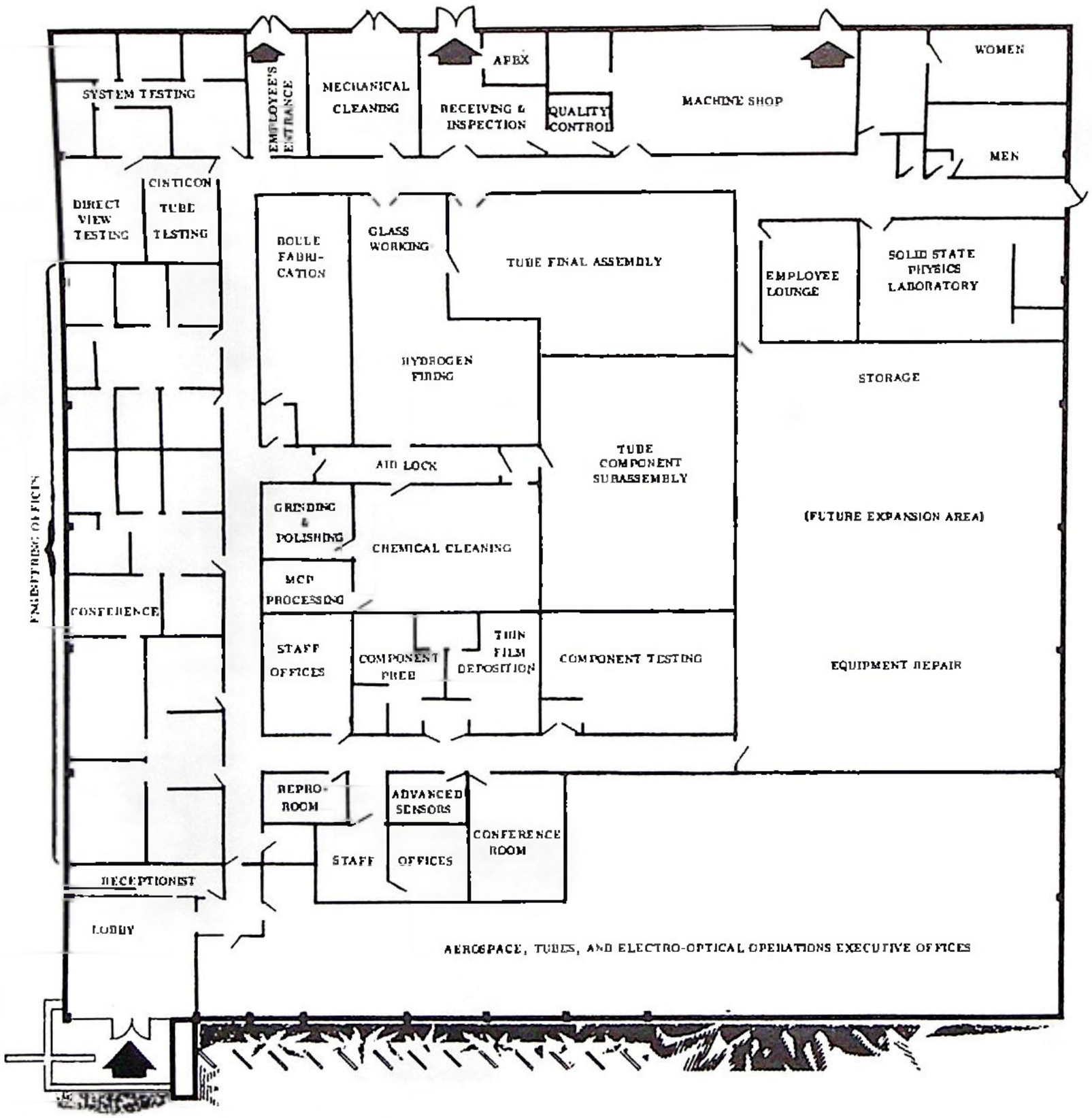

Figure 4. Advanced Electro-Optical Laboratories Facility Diagram

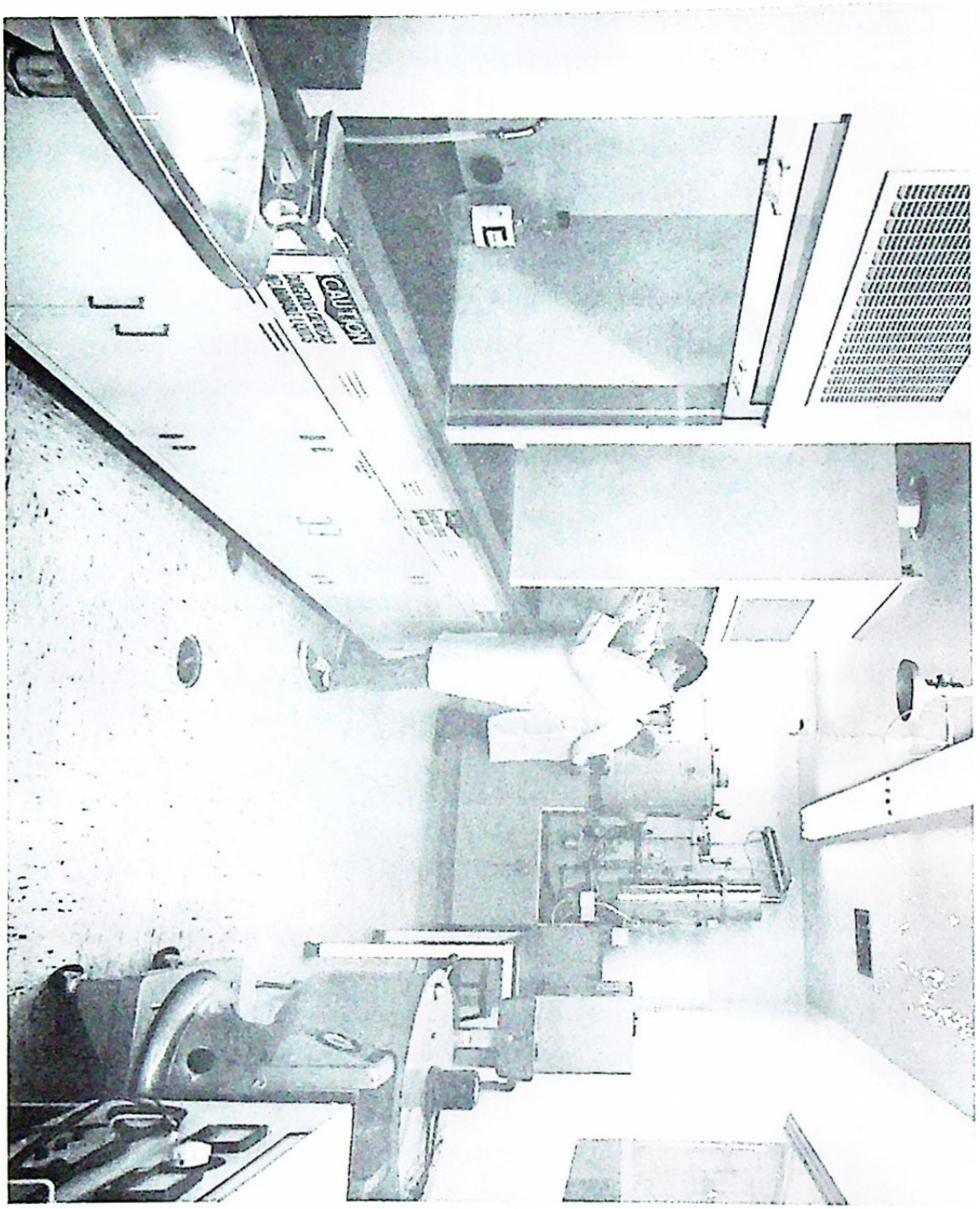

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Figure 5. Chemical Cleaning Area

Grinding and Polishing

This room contains glass saws, glass edgers, and grinding–polishing machines for cutting, grinding, polishing, and edging of fiber optics, faceplates, and other glass parts used in tube fabrication (Figure 6).

MCP Processing

In this area the rounded and polished MCP blanks which are sliced from an etched core boule are chemically etched to remove the channel core glass. Nonactivated MCP's, either from the etched core or hollow draw process, are thoroughly cleaned by a flowthrough technique or ultrasonically cleaned in preparation for deposition of thin film electrodes and final activation by hydrogen firing.

Component Preparation

This room is especially equipped for preparing cathodoluminescent phosphor screens or thermo–emissive cathodes by settling under laminar flow hoods or by centrifuging. Auxiliary equipment includes ball mills, automatic sieves, electric mixers, microscopes, drying ovens, and precision balances. A UV light source is used for checking uniformity of the screens and also is used with a densitometer to measure the transmission of the phosphor backing aluminum film.

Thin Film Deposition

This facility is equipped with three 18 inch diameter bell jar vacuum systems outfitted for vacuum deposition of thin films. High vacuum for these systems is provided by integrally mounted electronic Vaclon pumps, while all mechanical roughing pumps are remotely located to prevent contamination from oil vapors. Two of the deposition systems have resistance heating, and one has an electron beam evaporator. They are used for aluminizing phosphors, preparing storage screens, depositing reflective coatings on mirrors and applying conductive areas or other thin films required in tube fabrication. Complex electronic and optical monitors are used to ensure the deposition of uniform thin films of proper thickness and physical properties (Figure 7).

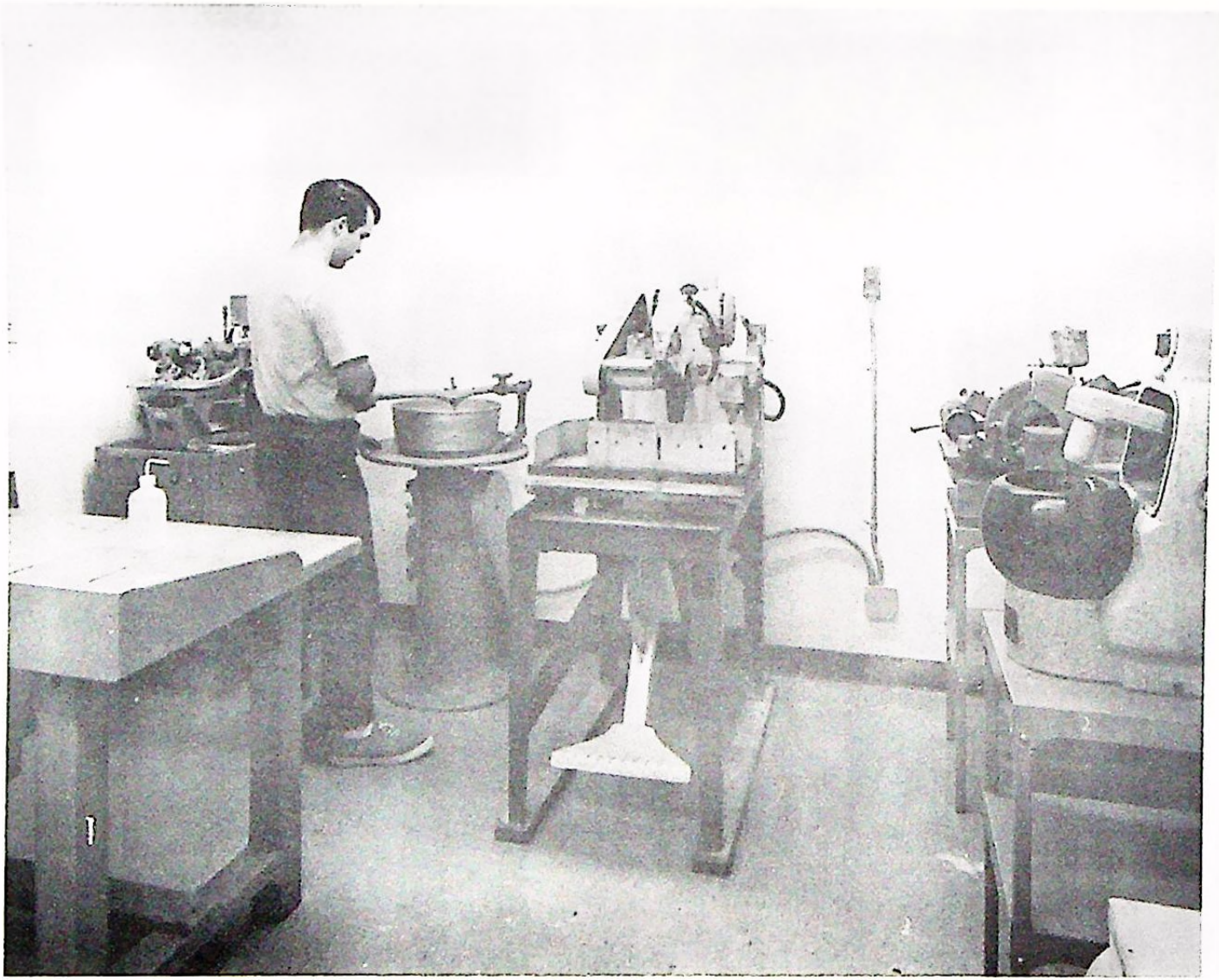

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Figure 6. Grinding and Polishing Area

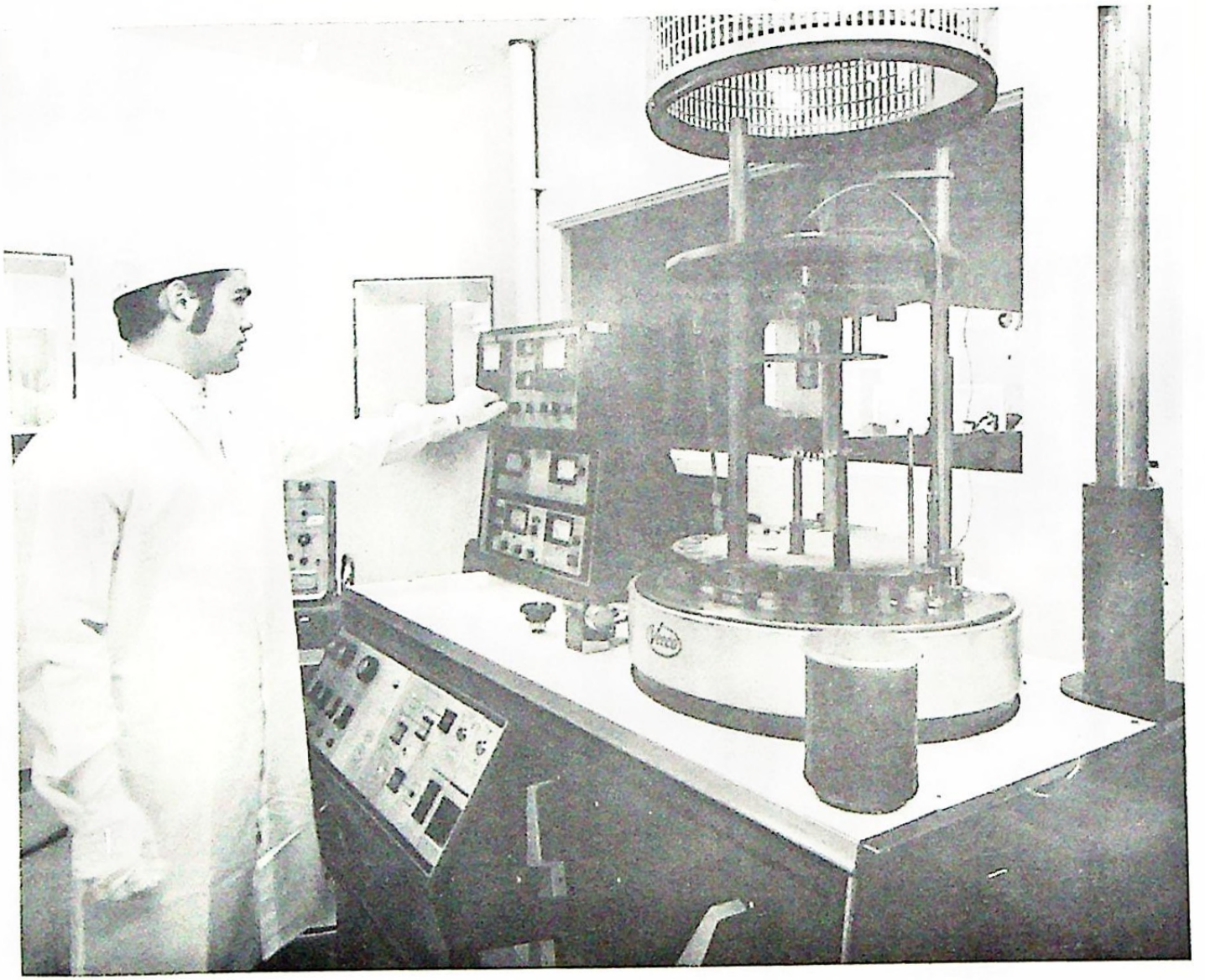

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Figure 7. Vacuum Evaporation Apparatus, Thin Film Deposition Area

Component Testing

This is a clean room equipped for testing tube components including fiber optics, microchannel plates, phosphor plates, and related subassemblies. Maximum use is made of photographic techniques to document the test work. Equipment includes: (a) Leitz research binocular microscope fitted with photographic attachments for 35 mm, 4 x 5 inch, and Polaroid cameras, (b) special demountable systems for measuring gain, resolution, and resistance of microchannel plates, (c) equipment for testing phosphor and tube breakdown under operating voltages, (d) equipment for measuring phosphor resolution and efficiency, and (e) equipment for testing CINTICON targets (Figures 8 and 9).

Tube Component Subassembly

This is a clean room equipped for the subassembly of various components into photoelectronic image tubes. Assembly benches with laminar flow hoods are used for critical components and operations. The tube components are accurately aligned in special fixtures for assembly processing. Equipment includes precision spot welders, plasma arc welder, and a high frequency RF generator equipped for making glass-to-metal seals in an inert atmosphere (Figures 10, 11, 12, and 13).

Tube Final Assembly

The final assembly of all types of image tubes is performed in this area. It contains eleven vacuum pumping and baking stations equipped for the formation of photocathodes, cathode-to-tube assembly, evacuation, and sealing of image tubes. Differently designed vacuum processing chambers, interchangeable between most stations, permit work to be performed on a wide variety of tube types. Chambers are available for the individual processing of a single tube or the simultaneous processing of several tubes (Figure 14).

Glass Working

Since glass blowing techniques are used both in the fabrication of some image tubes and also in tube production equipment, AEOL is equipped with a complete glass working facility. Equipment in this area includes glass working benches, a Litton horizontal glass lathe, glass fritting oven, glass annealing oven and a fiber optic boule tacking oven. Complete hand tools are available, and a large stock of tube and vacuum system glasses is maintained.

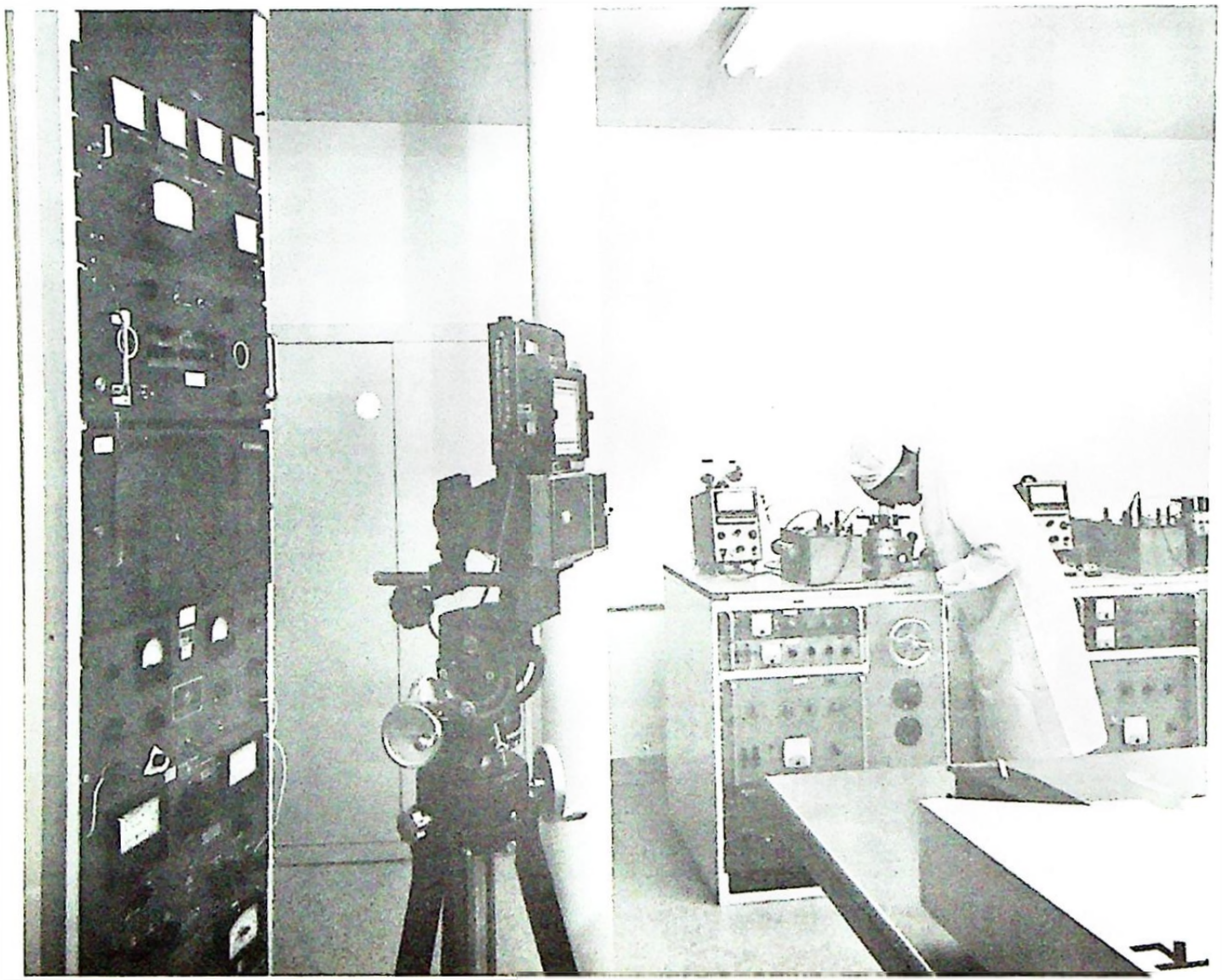

Figure 8. CINTICON™ Target Test Console, Component Testing Area

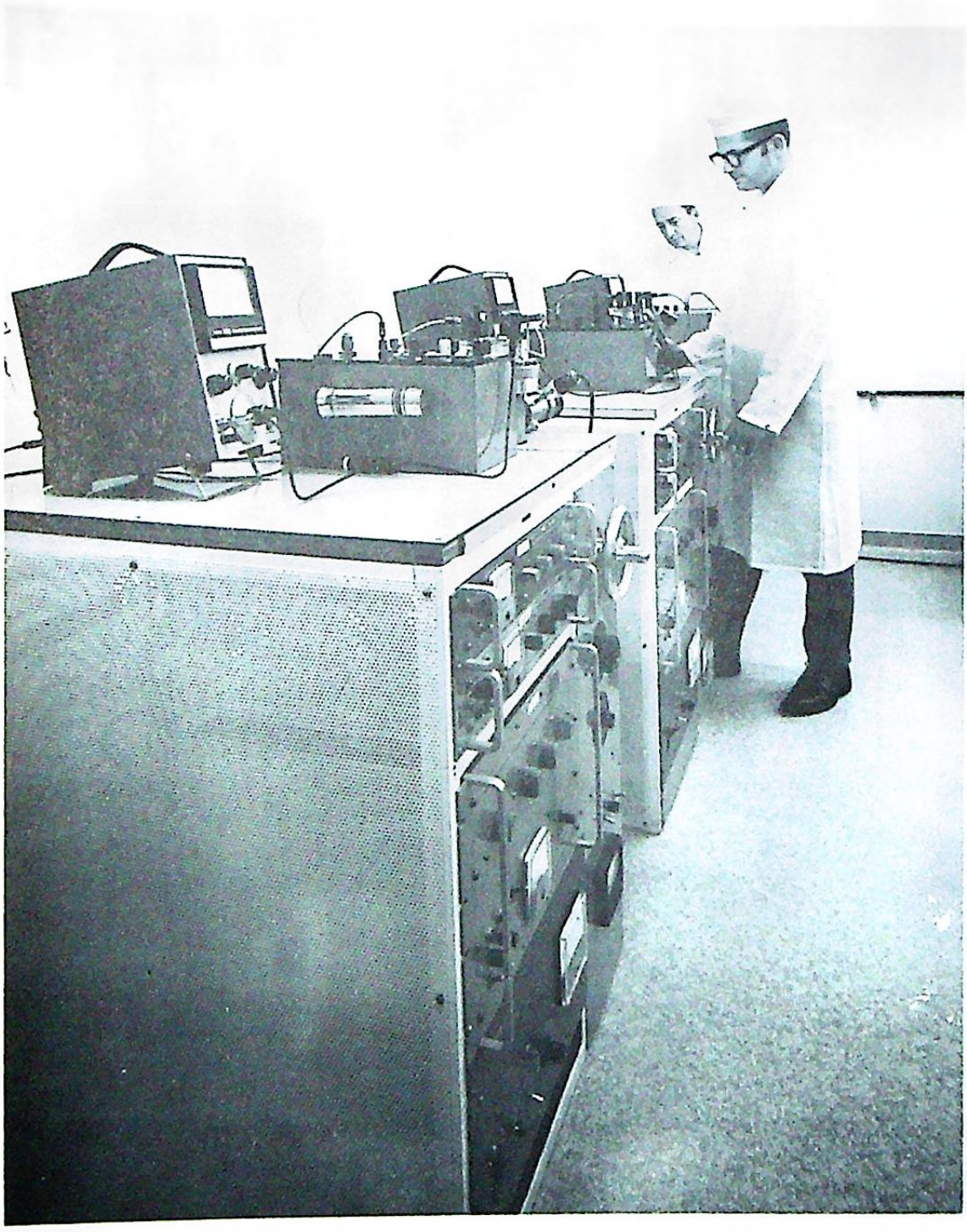

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Figure 9. MCP Demountable Test Stations, Component Testing Area

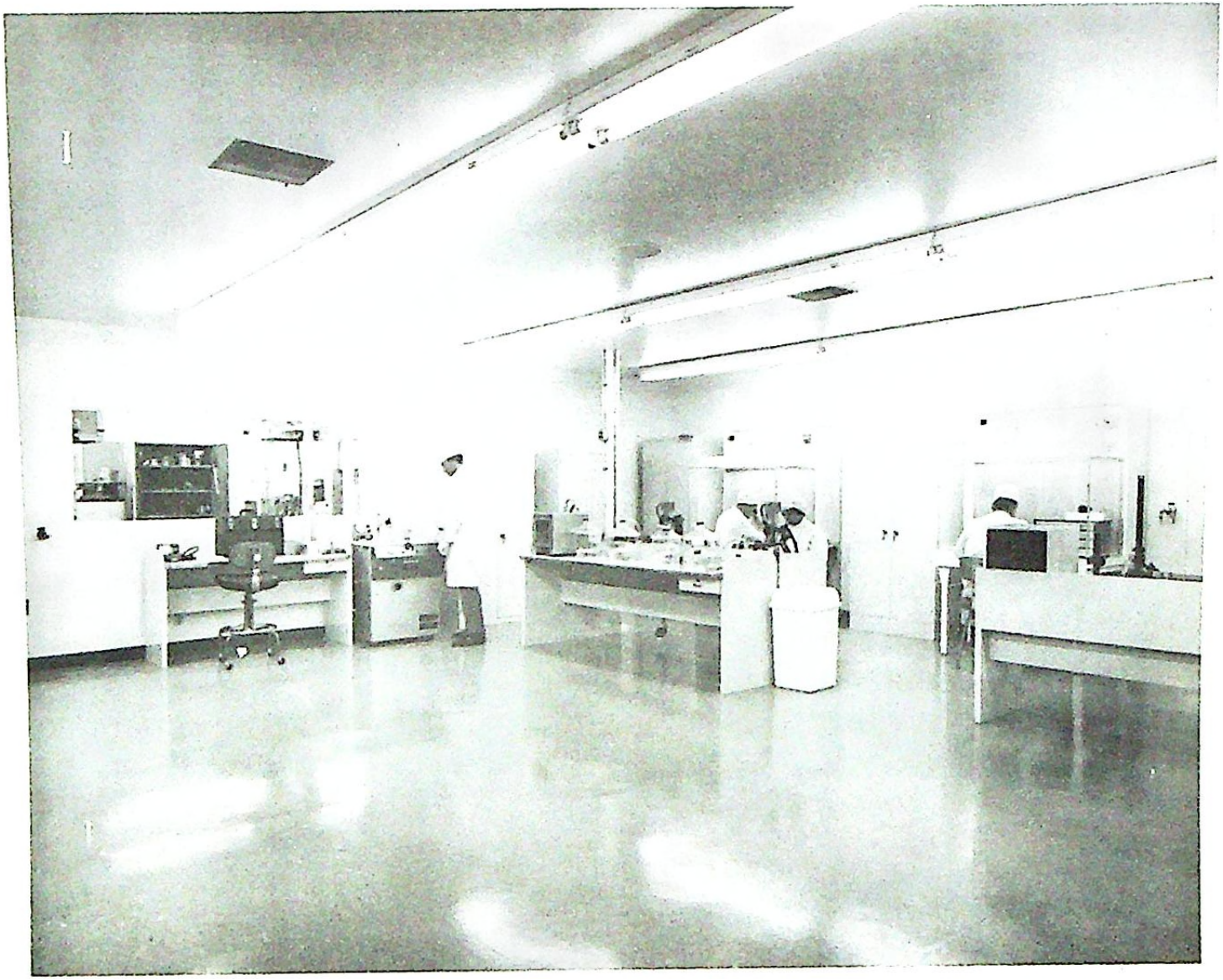

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Figure 10. Tube Component Subassembly Area

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Figure 11. Laminar Flow Assembly Benches, Tube Component Subassembly Area

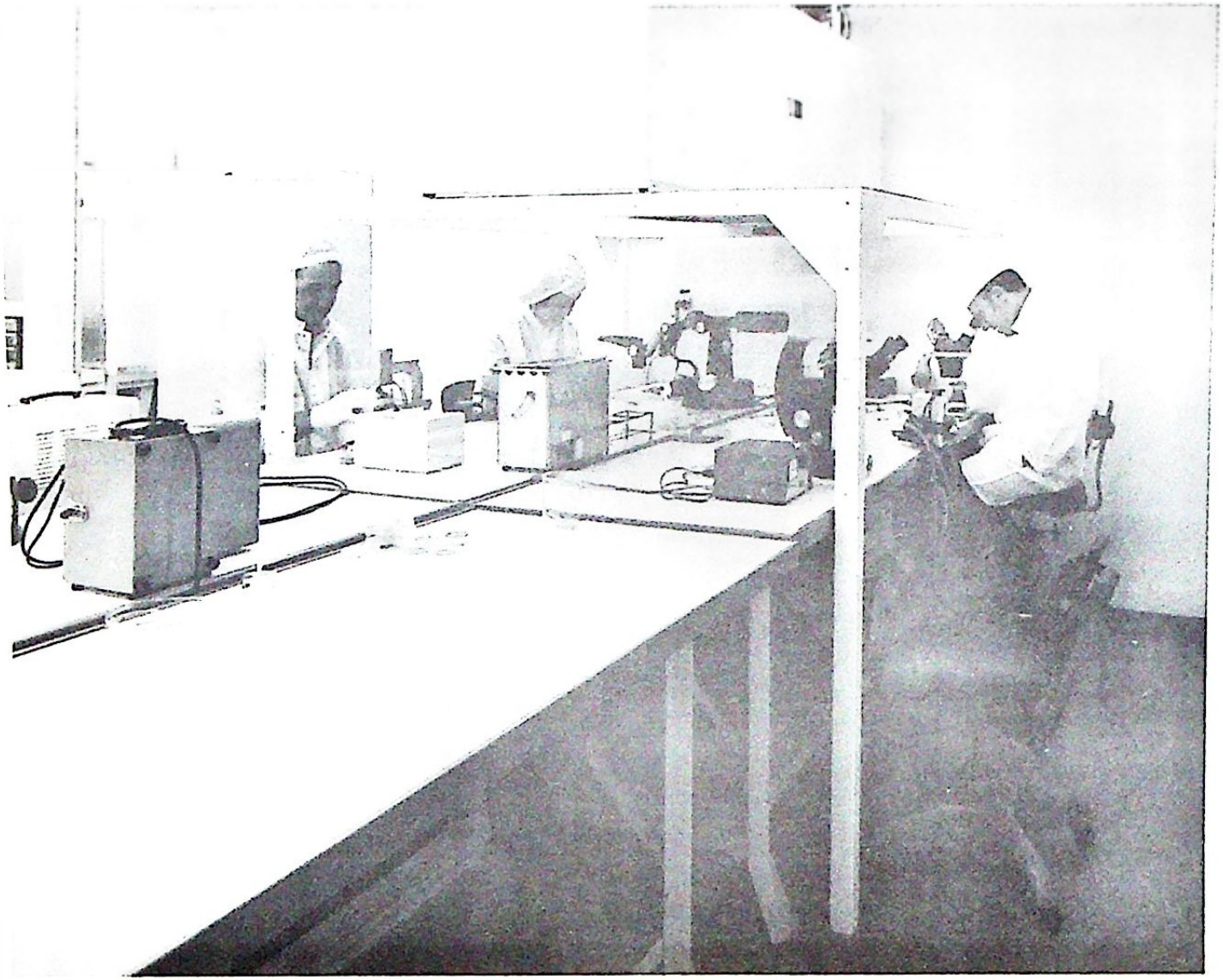

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Figure 12. CINTICON™ Assembly Station, Tube Component Subassembly Area

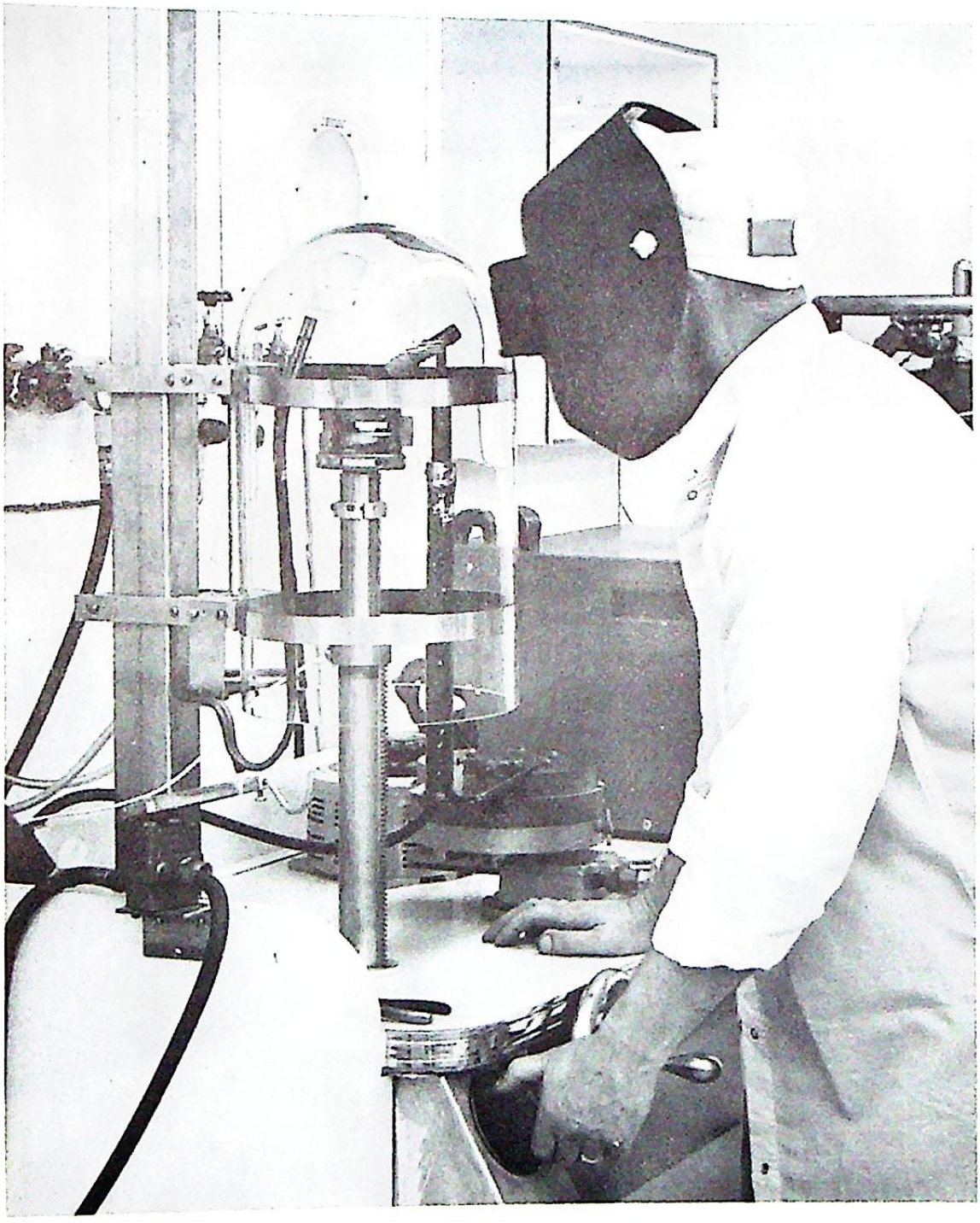

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Figure 13. Inert Atmosphere Welding, Tube Component Subassembly Area

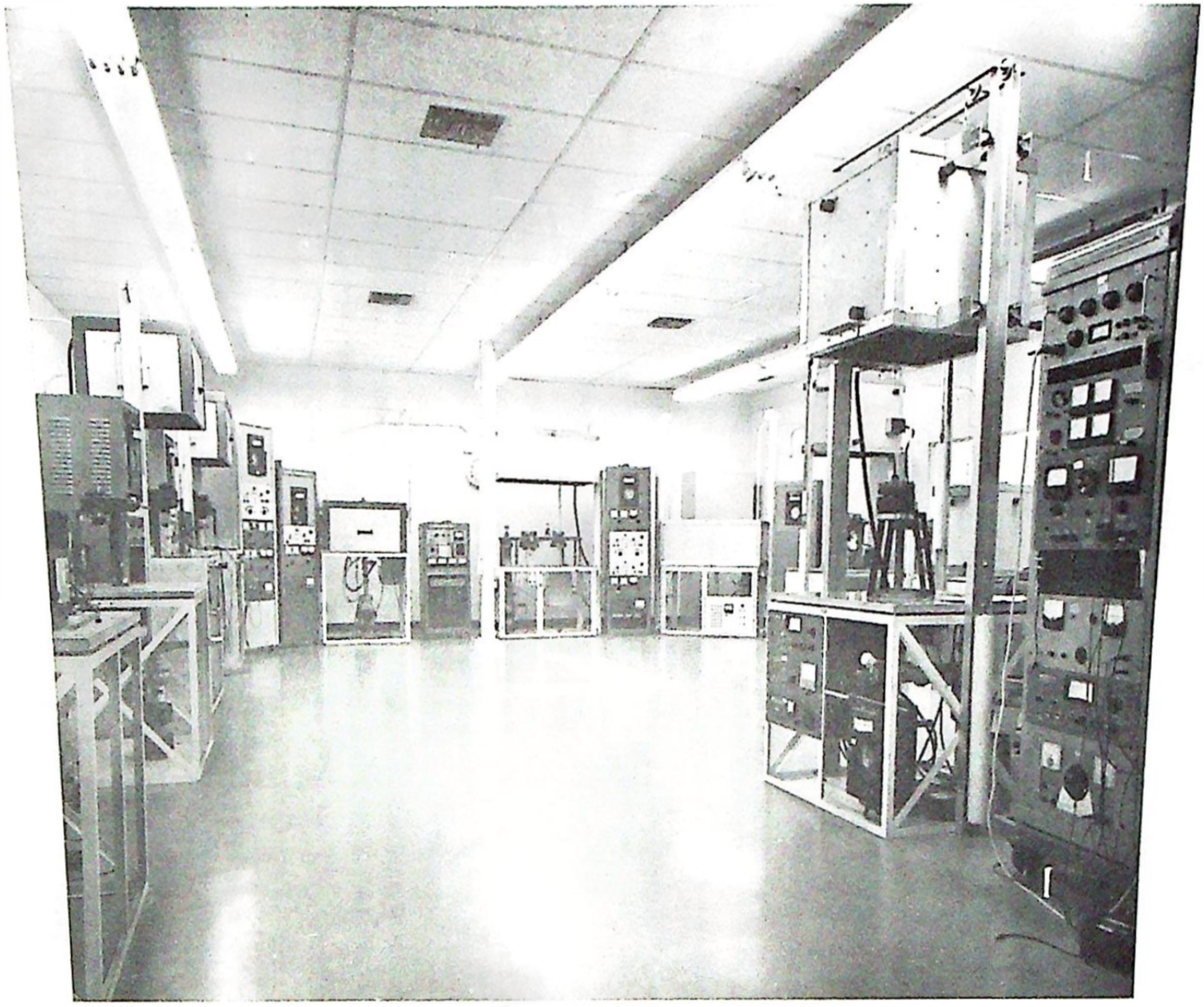

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Figure 14. Vacuum Processing Stations, Tube Final Assembly Area

Hydrogen Firing

This room is equipped with an outstanding collection of equipment for processing tube components, microchannel plates, and fiber optic work. The Stewart furnaces are equipped for dry and wet hydrogen firing of parts and for inert atmosphere brazing of metal or metal-ceramic assemblies. Equipment is installed in an air conditioned room with ventilating hoods and safety equipment and includes (Figure 15):

- One 8 inch Stewart muffle furnace.
- Two 3 inch Stewart muffle furnaces.
- One glass fusing furnace with 72 inch linear hot zone with vacuum muffle.
- One glass fusing furnace with 36 inch linear hot zone with vacuum muffle.
- Two Lindberg heavy duty 50 inch diffusion furnaces for hydrogen activation and diffusion processes equipped with programmable Datatrak temperature recorder/controller.
- One Lindberg heavy duty 18 inch diffusion furnace.
- One 7.5 kilowatt RF generator.

MCP Boule Fabrication

This is a clean, high bay area in which is installed an etched core fiber drawing machine used for conventional MCP production and a large hollow tube drawing machine which is almost automatic in its operation. Other equipment in this area includes laminar flow work benches which are used for the inspection and packing of the boules and special deep well ultrasonic equipment for cleaning long lengths of glass (Figures 16, 17, 18).

Direct View Testing

This area is equipped for the testing of direct viewing image tubes at light levels over a range from 10^{-8} footcandles to 100 footcandles. An integrated test console provides an optical system, power supply, and controls for performing the tests. Interchangeable tube mounts and adjustable optics permit the testing of electrostatic, electromagnetic, or proximity focused image tubes with a wide range of photocathode diameters. Auxiliary instrumentation is provided for measuring the input light level on the test object and the output light level on the viewing screen phosphor. Both two

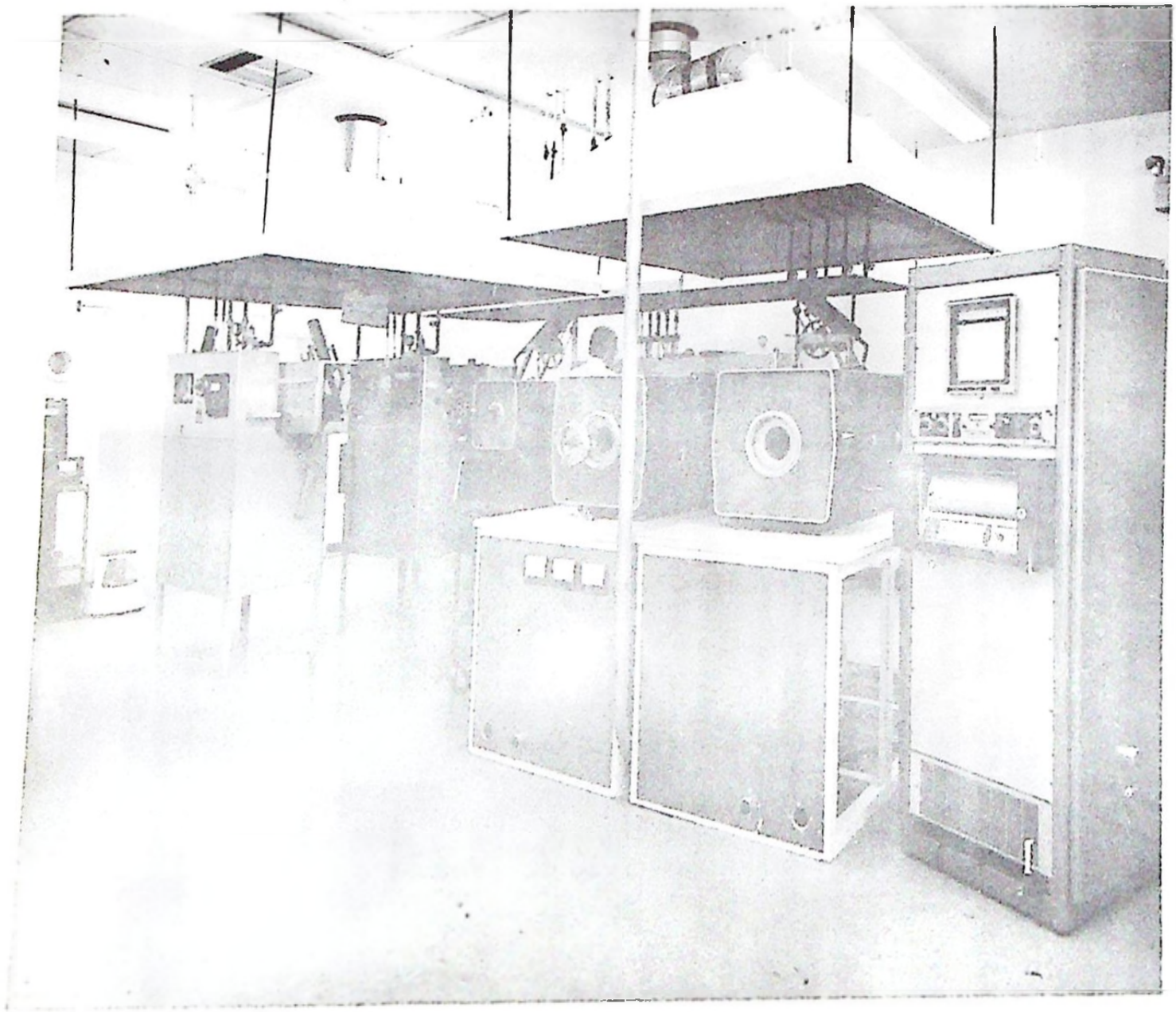

Figure 15. Gas and Electric Muffle Furnaces, Hydrogen Firing Area

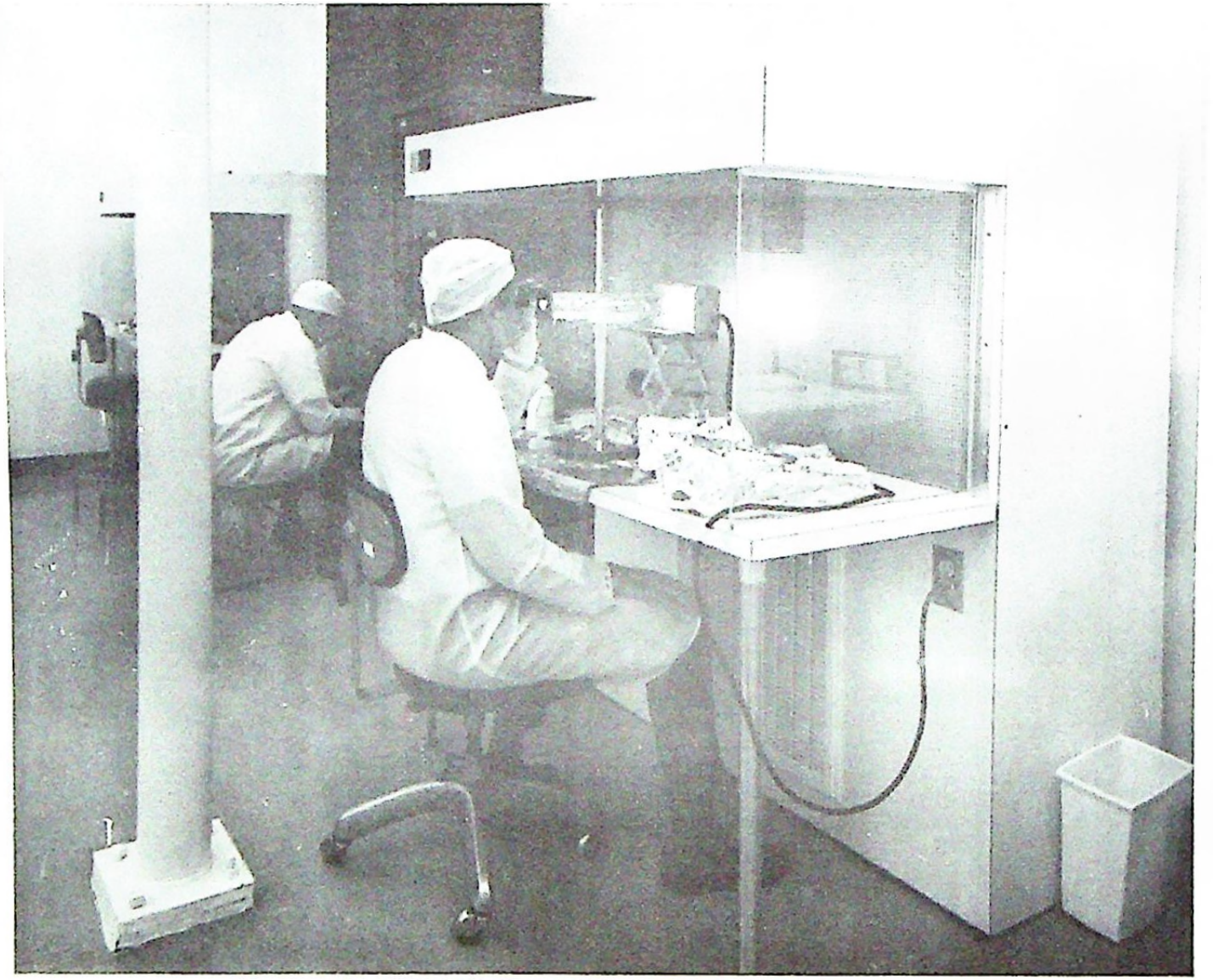

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Figure 16. MCP Boule Fabrication Area

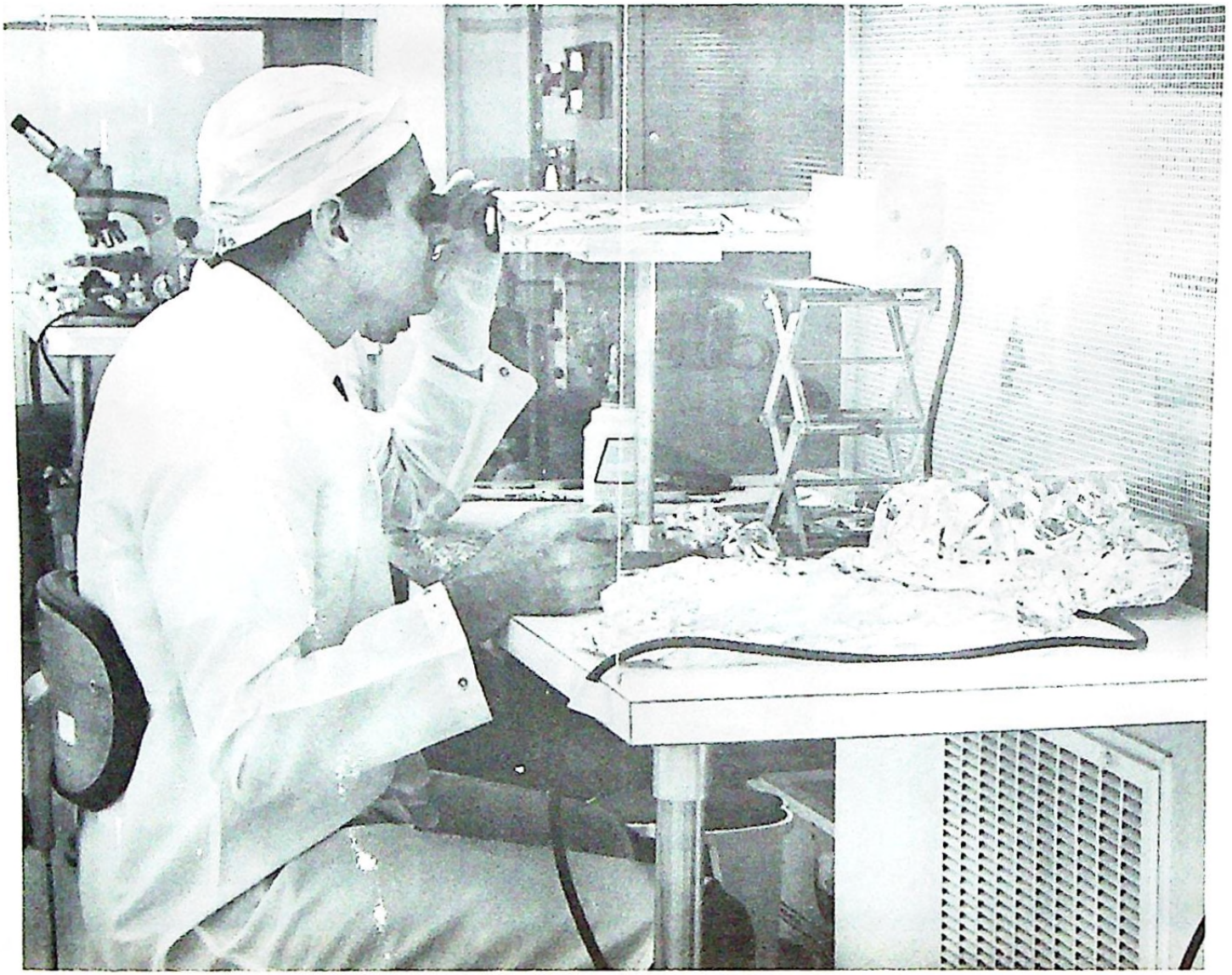

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Figure 17. Single Fiber Packing, MCP Boule Fabrication Area

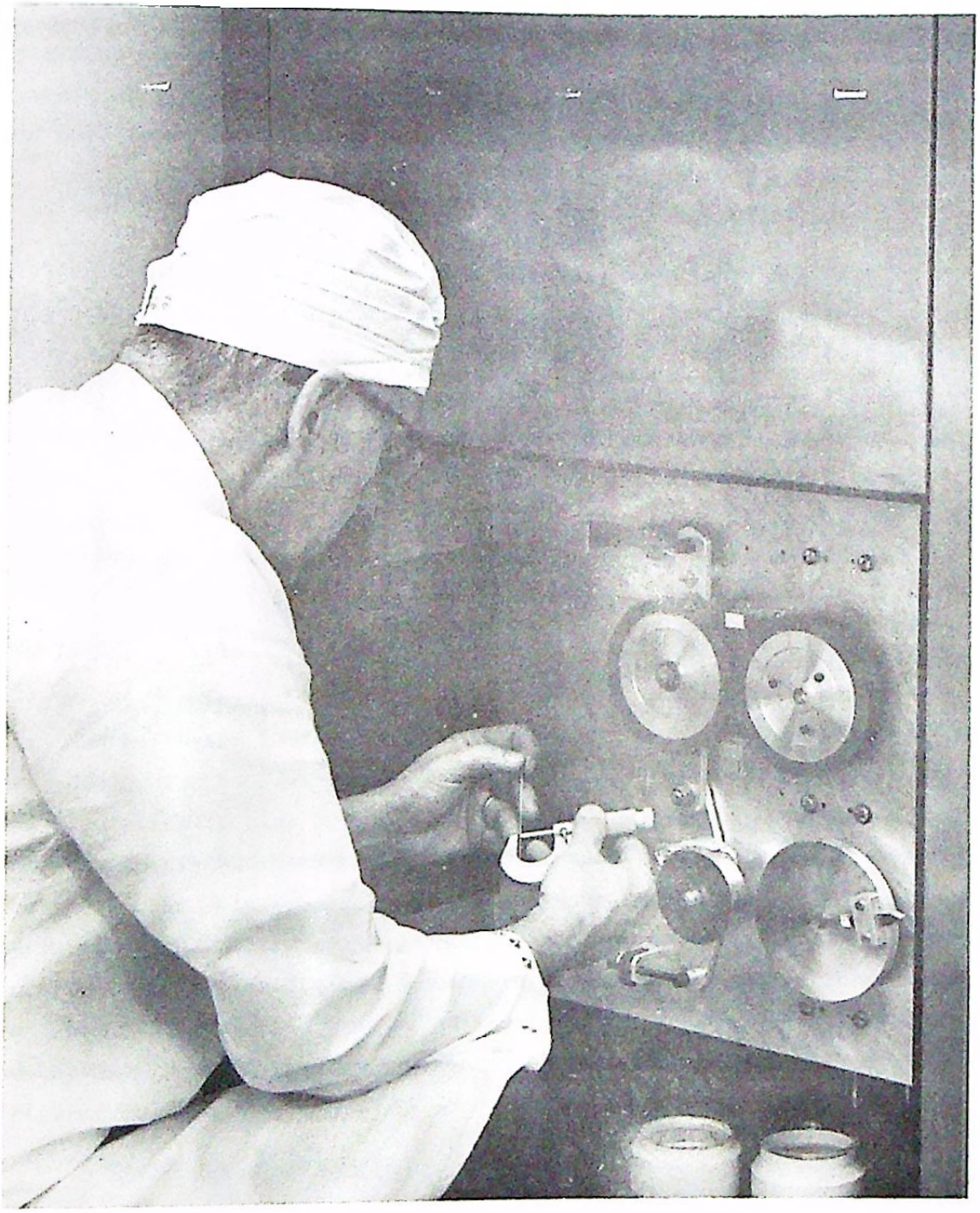

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Figure 18. Etched Core Fiber Drawing Equipment, MCP Boule Fabrication Area

and three dimensional targets are used in these test procedures. Photography is used to provide permanent records of tests (Figure 19).

Other equipment in this room is an instrument for the automatic determination and plotting of the modulation transfer function for optical systems or image tubes. The equipment includes a precision optical bench and collimated light source as well as the automatic plotter.

CINTICON™ Tube Testing

The CINTICON™ test facility is designed exclusively for the test of Generation II camera tubes under extremely low light level conditions. An integrated test console provides power, controls, and displays for determining the performance parameters of CINTICON™ tubes. A lightproof test compartment containing an ultralow noise level camera is used to provide the dark test environment while allowing test operations at a higher light level. Light levels, resolution patterns, and bandwidths may be changed for complete tube testing. Plans for increasing CINTICON™ production provide for equipping the CINTICON™ test with a shielded low electromagnetic noise environment. Either electrostatic or electromagnetic vidicon type camera tubes (or cameras) may be tested with the same equipment (Figure 20).

System Testing

The system testing area is a suite of rooms in which the final tests are made on the completed tube assemblies. Five of the rooms are lightproof and have nonreflective coatings of flat black paint on the walls and ceilings. These rooms are equipped with photometric measuring equipment, optical equipment, and other electro-optical hardware used in the determination of performance parameters of photoelectronic image devices. Major equipment located in this area includes photometers, standards, narrow band spectrally variable light sources, controlled level light sources, optical benches, x-ray bombardment machine, and an environmental test chamber for thermal testing (Figures 21, 22).

Mechanical Cleaning

This area is equipped for the abrasive cleaning of tube components and fixtures. Equipment includes an SS White "Airbrasive" unit and a "Vacublast" system. In addition to abrasive cleaning, this equipment is

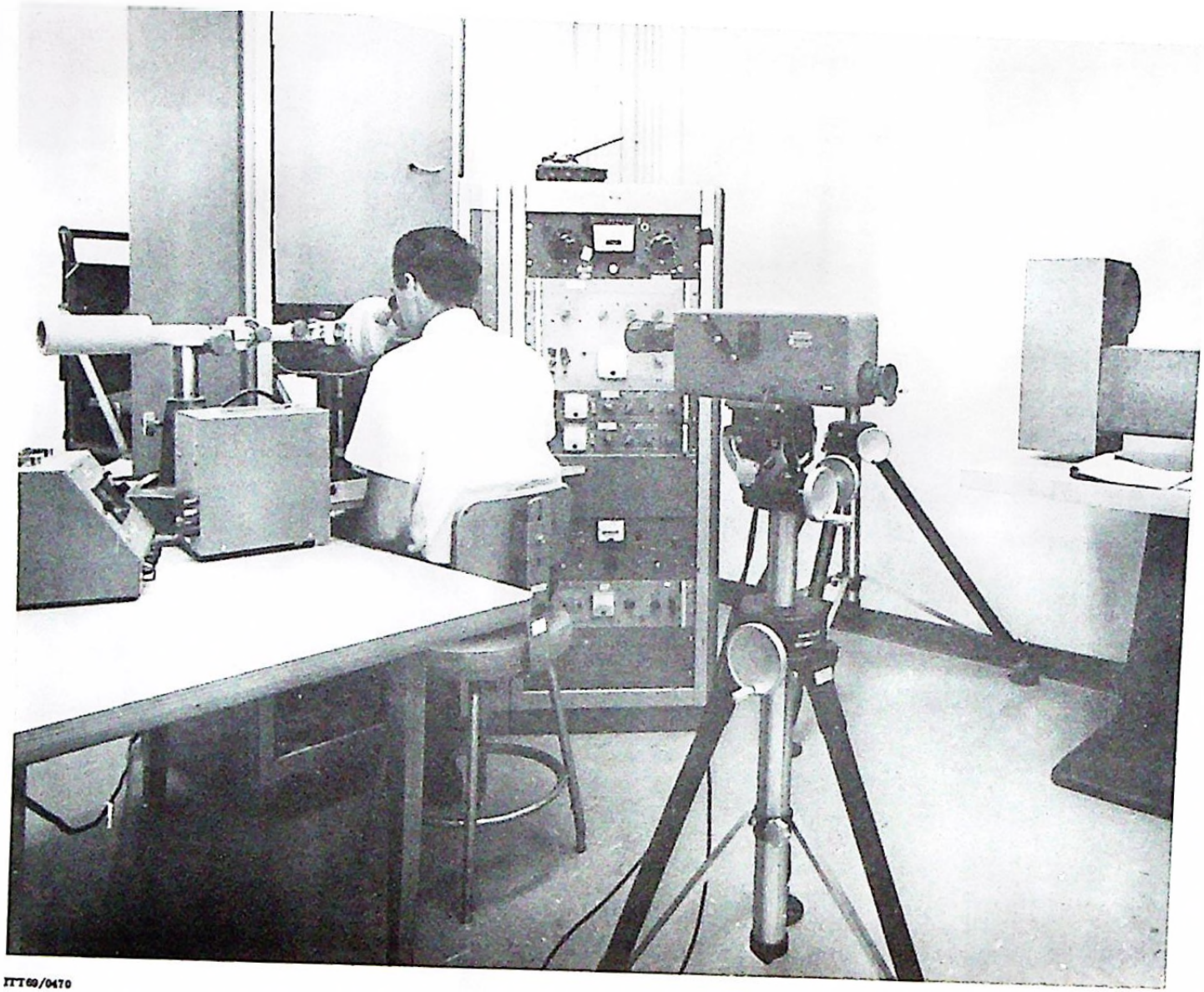

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Figure 19. Direct View Tube Testing Area

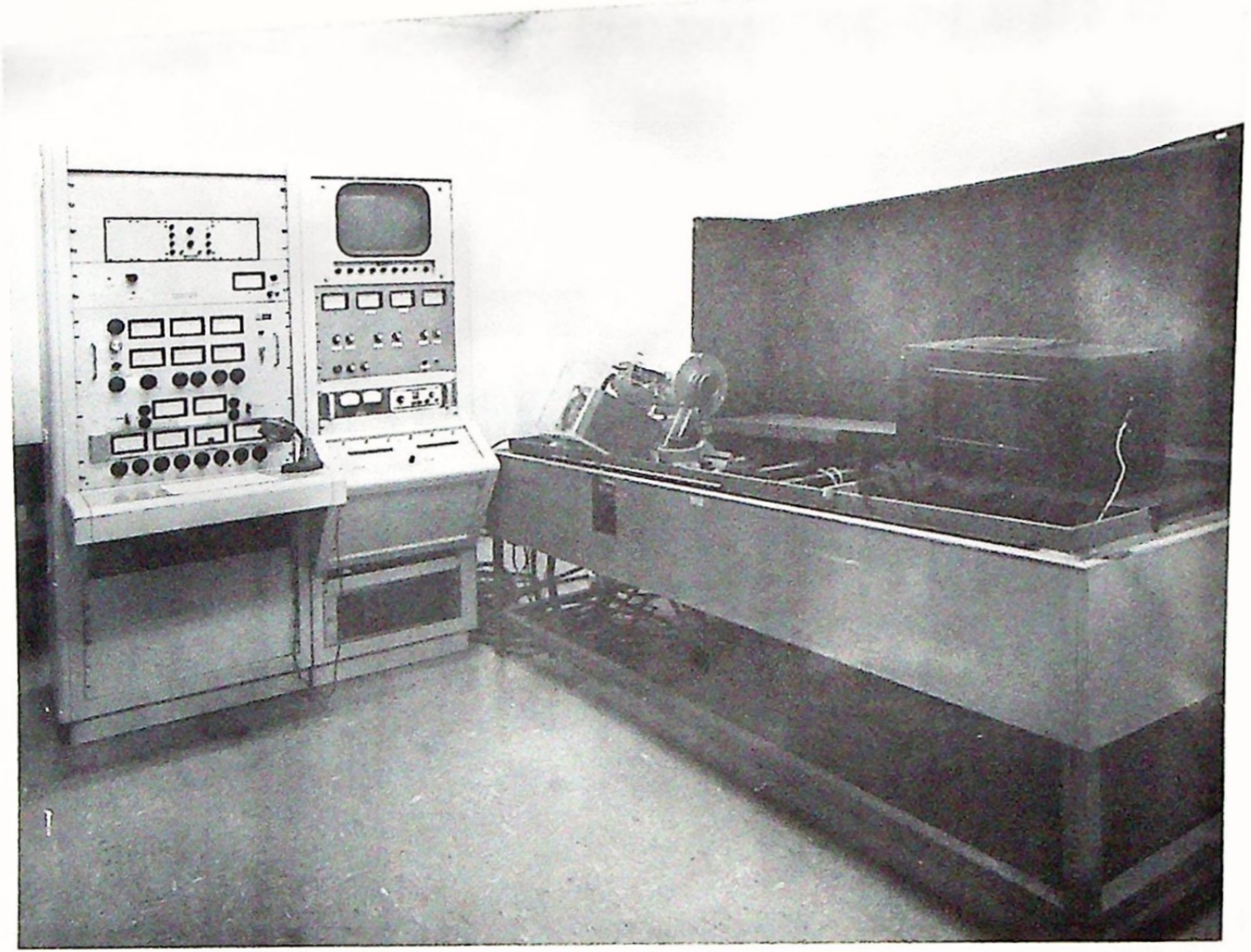

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Figure 20. Display Console and Test Compartment, CINTICON™ Tube Testing Area

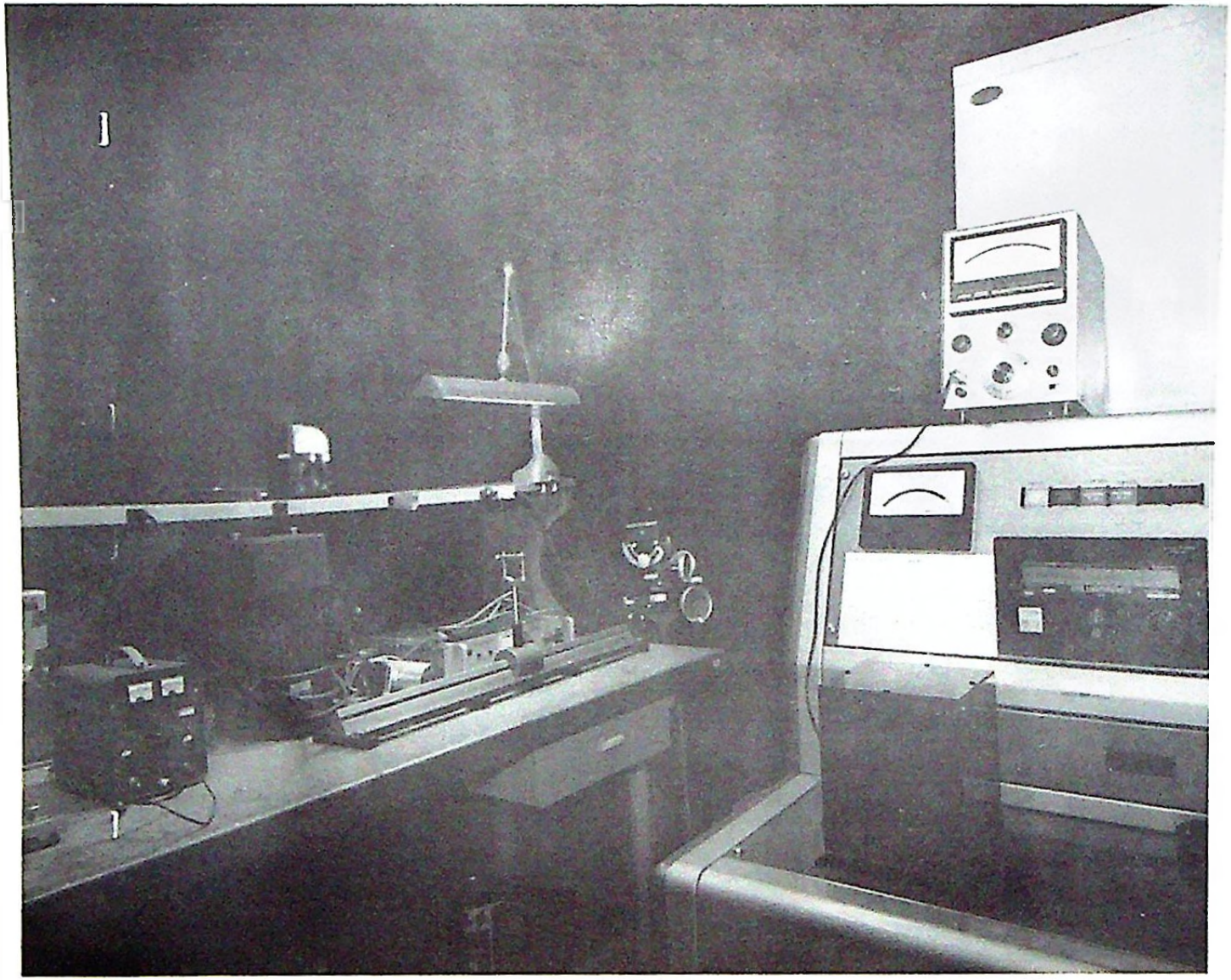

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Figure 21. Spectral Response Test Console, Systems Test Area

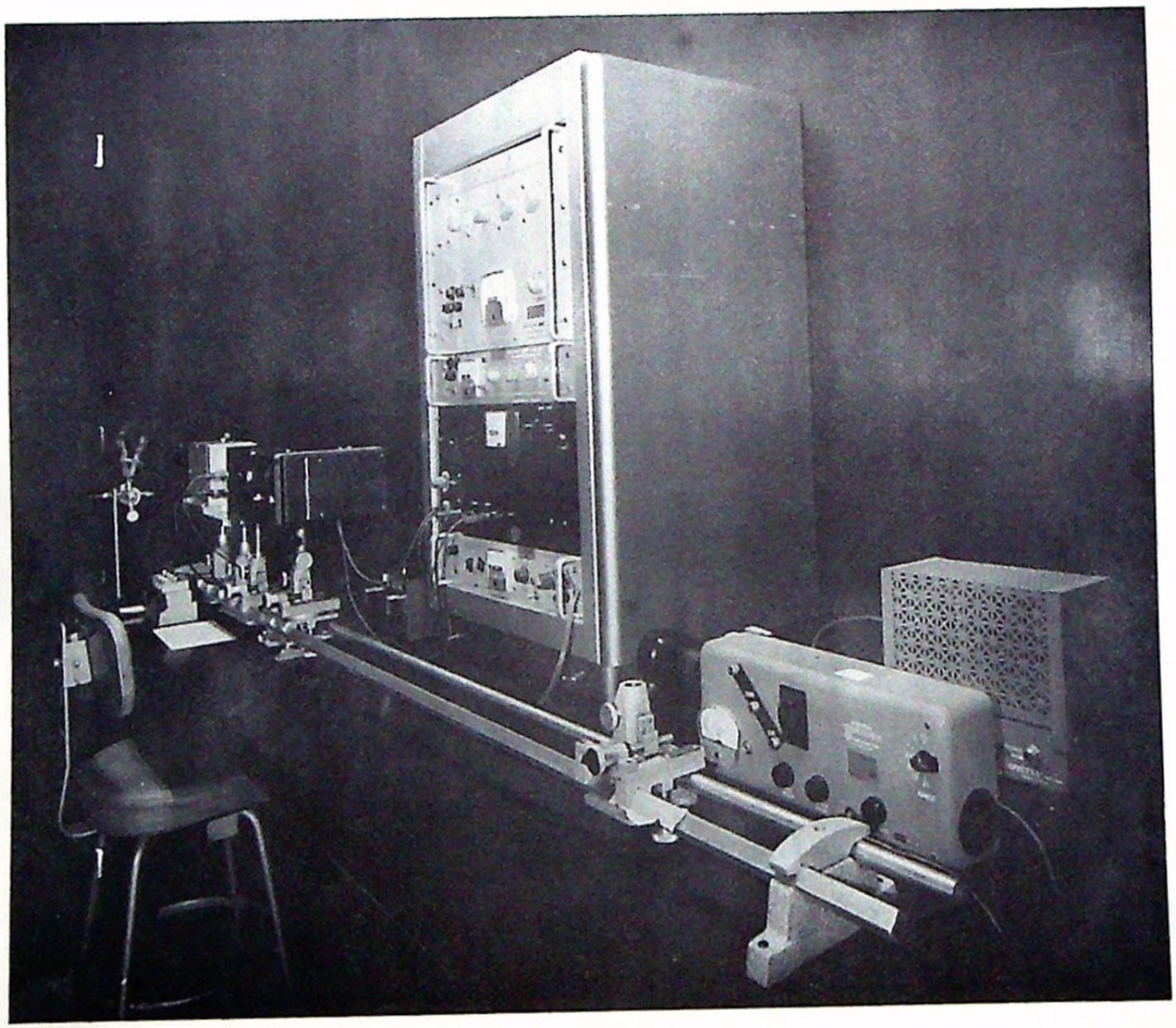

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Figure 22. Gain and Resolution Testing Equipment, Systems Test Area

also used to produce dull or matte finishes on some metal components. Also located in this area is the central air compressor and the central vacuum unit of a built-in vacuum system with inlets in all working areas.

Shipping, Receiving, and Inspection

Since quality control begins at the back door, Shipping and Receiving is under the direction of that department. Here all incoming raw materials or purchased components are inspected to determine if they comply with specifications before being placed in controlled storage for a particular project. All outgoing products are inspected and shipped in accordance with applicable security requirements.

Quality Control

The Quality Control Department at AEOL carefully monitors all phases of tube fabrication. This includes receipt of incoming components and raw materials, inspection of intermediate phase assemblies, verification of performance and shipment of the completed tube assembly. The Quality Control Department has both the organization and equipment to meet the image tube production requirements of both commercial customers and the Government as imposed by MIL-Q-9858. Equipment used includes microscopes of both high and low magnification, optical comparator, monochromatic light source, measurement standards, and various physical inspection tools (Figure 23).

Machine Shop

The machine shop provides the Advanced Electro-Optical Laboratories with a diversified capability for supporting both developmental and limited production programs. Equipment available includes lathes, vertical and universal mills, drill presses, grinders, rotary punch, band saw, sheet metal brake, power shear, power hack saw, jewelers' lathe, welding equipment and miscellaneous accessory tools. The nearby ITT Aerospace/Optical Division facilities have extensive and elaborate machine shops which are available for performing work which is beyond the capability or capacity of the AEOL facility.

Solid State Physics Laboratory

This area is especially equipped to perform research on solid state image intensifiers. Equipment includes (Figure 24).

- One Jarrell Ash spectrograph.

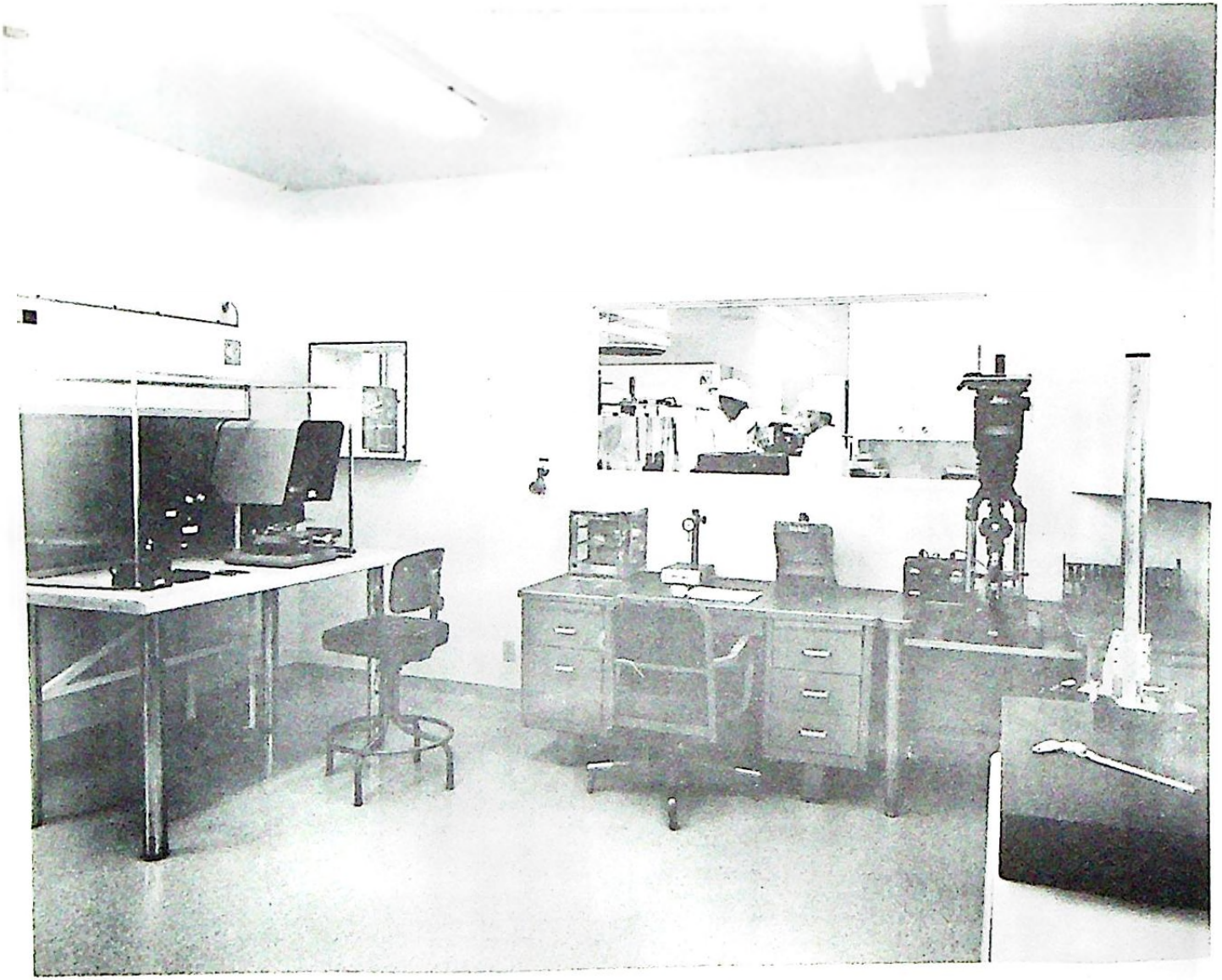

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Figure 23. Inspection Instrumentation, Quality Control

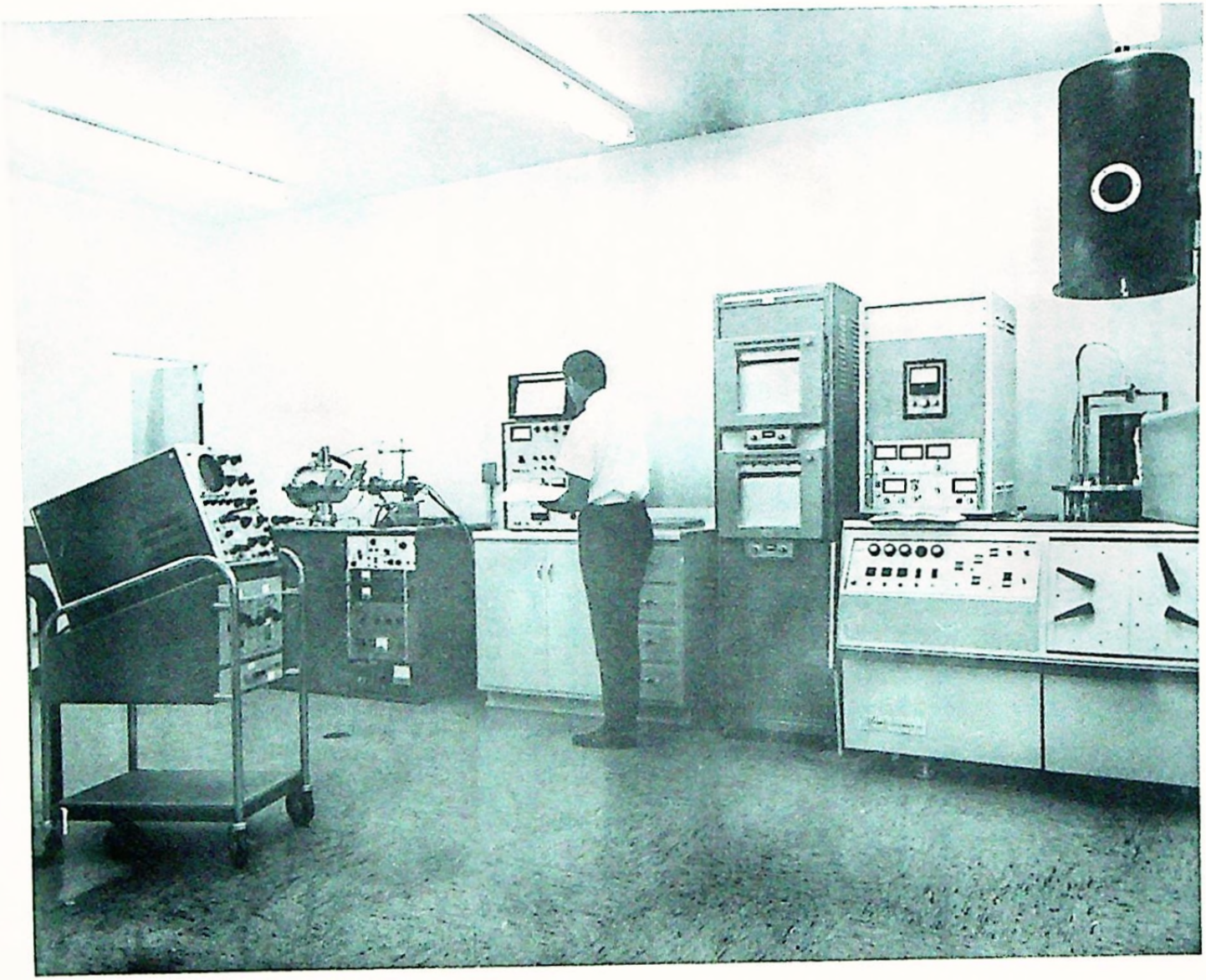

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Figure 24. Solid State Physics Laboratory

- One Veeco 776 evaporator system with Barber Coleman recorder/controller.
- One General Electric mass analyzer.
- One ultrahigh vacuum microchannel plate test chamber for checking material behavior in microchannel plates at elevated temperatures.
- One darkroom.
- One chemical deposition room with Lindberg diffusion furnace.

Advanced Tube Development

This area is an auxiliary laboratory for the Solid State Physics Laboratory in which is conducted an experimental program for the development of a solid state direct viewing image tube. The equipment in this area includes a variety of electronic, electro-optical, and optical test equipment for measuring the performance of experimental image devices.

Future Expansion Area

At present this large, air conditioned area, shown on the facility diagram (Figure 4), is used only for equipment and material storage and for equipment repair. Future plans call for the conversion of this area into additional offices, laboratories, an enlarged Quality Control inspection facility and an expanded pilot production capability. With the exception of the office spaces, all these new additions will be in a closed, controlled clean room environment.